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AUTHOR Chen, David; Brovey, Daniel J.
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ABSTRACT

Educational change does not occur overnight, but the introduction of information technology will initiate a chain reaction of changes in the curriculum, instruction, and organization of education. Research on the process of change both identifies factors involved in the introduction of innovations and suggests guidelines for educators. Two phases in the pursuit of change can be defined: (1) developing readiness in the educational system by teaching about the technology and redefining the educational problems amenable to technological handling; and (2) experimenting and exploring the solutions offered by technology to central problems in education, followed by diffusion and implementation. Teachers and curriculum decision makers and developers must be prepared to cope with the transition from a rigid format to a flexible one. Changes in instruction would enable increased productivity of learning, mainly through individualizing, i.e., adapting the instructional process to learner variables through automated diagnosis, advanced computer managed instruction, or the development of individualized instruction systems. Organizational changes resulting from the availability of information technology may include the home as an alternative site for learning, special interest study groups, and educational networks. Such changes should be approached with careful planning in order to minimize the social cost of hasty changes based on unrealistic expectations and beliefs. (EW)

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INFORMATION TECHNOLOGY AND THE EDUCATIONAL SYSTEM: I. IMPLICATIONS FOR ORGANIZATIONAL DEVELOPMENT

An invited paper for the First National Technology Leadership Conference
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School of Education Tel Aviv University Tel Aviv Israel
Queens College Flushing New York U.S.A.

Introduction

It took western society almost two hundred years to adapt to the innovations of the industrial revolution. The technology of energy transformation did not mean just the exchange of mechanical tools for the manual labor, cars and trains for horse carriages, or electricity for candles and kerosene lights. The organization of production complexes, the establishment of modern trasport systems, and the mechanization of farming procedures were associated with massive urbanization, extreme changes in the pattern of economical relationships, and an entire restructuring of an intricate social fabric. Ideologies, division of labor, land, capital, and cultural institutions were all deeply affected (1). It is, therefore, naive to expect the entire educational system to undergo spontaneous changes as a result of the revolution that is being shaped by information technology.

Yet, rosy expectations and predictions are being made by computer experts and proponents of educational technologies: When we purchase and "saturate" the classroom with microcomputers, when we acquire the "right" educational software, the scholastic achievements will improve dramatically, students will be able to "solve problems" that they couldn't solve prior to the computer age, they will overcome wrong intuitions, eliminate cognitive difficulties (now called bugs), and transfer skills from one domain specific area to another (2). Once we provide equal opportunity in access to information, the

distribution and production of knowledge by the educational system will become efficient and productive, in the same way that the production and distribution of goods was changed by the industrial revolution. Such enthusiasts simplify, if not completely ignore, the complex issues involved in the transition of a social system (such as education) to the technological era. If educational progress is made by using technology, it may take two hundred years, but it cannot happen overnight. A decade or more is a reasonable time frame as the educational system undergoes a delayed "Industrial Revolution". That education will change is a certainty as it responds to the introduction of information technology, a technology which, for the first time, is relevant to education main purposes and functions (3).

Preparing for Change: Lessons from the Past

The introduction of information technology to education will initiate a chain reaction of changes in the curriculum, instruction, and organization. What can we expect? The vast literature on the process of change provides many lessons from past experience in innovating and changing educational practices.

Havelock and Huberman (4) in their study on the theory and reality of innovation warn us "to respect the existing scheme of things, especially if it works and seems to be serving the psychological, social, and material needs of its members at some level of satisfaction". According to the authors, there are at least two

reasons for caution:

a. The system does not need the innovation (computers for that matter).

b. We may do more harm than good, by destroying delicate social infrastructures which were functioning in a way we never guessed.

These words of caution are particularly relevant when computer enthusiasts are trying to convince us that the new technology is the panacea for cognitive development, learning disabilities or equal knowledge distribution for all. What will really happen when we provide every school and even every student a computer? Not only we do not have the empirical answer, but even the pertinent questions are not formulated properly: Do we expect higher achievement in the general student body? Do we expect better equality? Do we expect increases in intelligence? Do we expect more individualization? Henry Levin (5) in his study of the meaning of Educational Reform, suggests that the educational system corrsponds to the social, economic, and political institutions of our society. Thus, "the only way we can obtain significant changes in educational functions and relations is to forge changes in overall social, economic, and political relationships that characterize the polity. No educational reforms will succeed if they violate the major tenets of these systems".

A graphical representation of Levin's mode is presented in Fig.1:

Basically, what Levine is telling us is that a successful

introduction of technology into education will require the support of the political decision-makers, reassessing educational goals, allocating budgets, moblizing resources, teachers, equipment, etc., and changing instructional and organizational practices. Only a coordinated effort at all these levels might produce the desired educational outcomes.

Aldefrer, (6) in his Analysis of Change Processes in Organizations, studies social technology on the basis of systems theory. One of the major conclusions of this study is that the nature of change and process vary according to the level of human unit that one considers the change target: the individual , the group , or the organization.

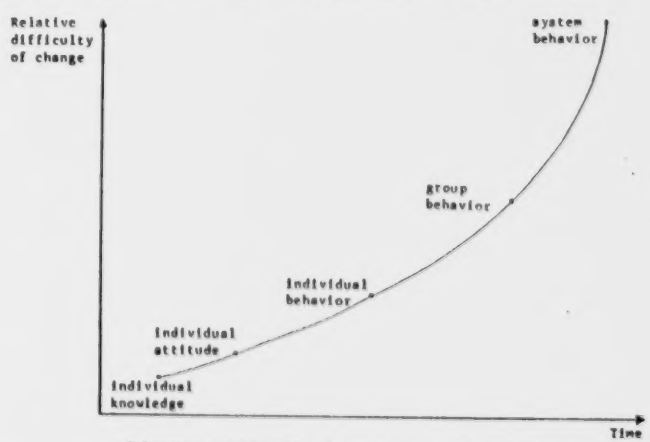
At the level of the individual , we usually focus on changing knowledge, skills and attitudes. At the group level, social interaction and communication is introduced. We are mainly concerned with internal and external relationships, the size of the group, and the openness of the boundaries.

At the level of the organization (or system), we are interested in the structural pattern, overall processes and outcomes, and the relationships between the groups (or sub-system).

The individual provides the primary internal unit of the group, and groups are the major unit in the organization. Change activities which address several levels simultaneously have greater likelihood of producing change, than change which address only one level. The

major lesson from Aldefrer's analysis is that a clear distinction in the objectives of change must be made when we approach the individual teacher, the school staff, or a district, region or state educational system. Teaching computer literacy and programming will produce different outcomes than staff development in communication and networking, training administrators in computer managememt. Instruction of researchers in software engineering have evidently another impact on the system. Nevertheless, the simultaneous work as well as the coordinated effort at the various levels is a highly important aspect if we want to introduce a planned change.

Ivor Morish, (7) in his book on Aspects of Educational Change, describes the relative time and difficulty involved in educational change. Changing the individual knowledge seems to be the easiest to achieve, next the attitude. However, the actual change of individual behavior occurs much later. The change of group behavior is a much more difficult task and requires more time. By extrapolating to Aldefrer's three levels of change, we may extend Morish's model for the relationships between time, difficulty, and change as follows:



Schematic relationships between time needed and change.

These relationships may set the trend for organizational development involving the introduction of sophisticated technology in a non-technological social institution. Possible priorities implied by this type of relationship in training effort will be discussed later.

At a more concrete level, Orlosky and Smith surveyed "75 Years of Change" (8) reviewing a variety of instructional curriculum and organizational changes in education. They justly suggest that planned change should be based on past experience analysis of all factors of education and current theories. Their major conclusions are briefly summarized here:

1. Changes in methods of instruction are apparently more difficult to make successfully than changes in curriculum or administration.
2. Changes in instruction are more likely to originate within the educational profession.
3. A change that requires teachers to abandon an existing practice and to displace it with a new practice risks defeat. Strong incentives for retraining must be made.
4. Curriculum changes involving the addition of subjects on updating or content are more permanent that changes in the organization and structure of the curriculum.
5. Social support is necessary for backing the change.
6. Efforts to alter the entire administrative structure or any considerable part of it are likely to be unsuccessful.
7. The lack of a diffusion system will lead to abortive change.

8. Changes will be resisted if they require educational personnel to relinquish power, or cast doubt on their professional role.

9. If the cognitive load is not heavy, i.e., not too many people are required to learn many new facts and procedures, a change is more likely to persist.

10. The source of change appears to have far less to do with the organizational levels.

11. The sophistication of the innovations require us to give proiority to the training of the individual teachers in terms of knowledge, skills and attitudes. Thus, staff development of the individual should precede organizational development.

The merging of I.T. and Education

The implementation of information technology for educational purposes involves many factors. Some factors are well known, others remain to be resolved through experience and experimenting (9).

Much about the technology is very well known; the architecture of the computers, the nature of input devices and the variety of output peripherals, communication principles as well as the gamut of intellectual technolgies necessary to make information technology operational: programming languages, knowledge simulation, data base organizations, etc. The technology is so much ahead of its educational applications, and still going, that acquiring knowledge and skills concerning the very nature of the technolgy can be a major

goal for teachers, educational administrators and researchers.

Similarly, the educational system is quite well known - the organizational structure is not too complicated to grasp. The learning processes are operationally defined.

The lesson from previous experience is that technology will be nothing but a fad and rejected if it is not going to provide an answer to some very basic needs of education or even worse - create new problems in addition to those we have got already. (Technology has always been known as a mixed blessing). The principle of problem solving should serve as a guideline in the search for organizational development of education, and the inter-face between information technolgy and the education system should be carefully and systematically explored. We can, therefore, define two phases in this pursuit of change:

1. Developing readiness in the educational system by teaching about the technology and redefining the educational problems ameanable to technological handling; 2. Experimenting and exploring the solutions offered by technology to central problems in education, followed by diffusion and implementation.

In the following chapter, we will try to explore possible trends within this first phase. The subject of the second phase will remain outside the scope of our paper. The exploration will be confined to three major elements of education: curriculum, instruction, and organization.

Preparing for Changes in the Curriculum

Curriculum is a key concept in education.

Basically, the curriculum is a representation of that segement of public knowledge that serves education for learning purposes.

Contemporary definitions of curriculum extend beyond the classical definitions to include teaching and learning methodologies affiliated with it.

To simplify matters, the heart of the curriculum is the text book (11). The text book provides the paradigm, on normative knowledge, a social consensus of the pertinent scientific community.

By modern terms, we could argue that the curricular text book constitutes a prepackaged information ready to be consumed by the students. The following are the characteristics of the traditional curriculum emanating from its printed form:

1. Once the information is packaged and printed in the text book, it is difficult to change it. The life-span of a traditional curriculum (and text books) is anything between 8-15 and more years.
2. The selection and choice of information for the text book is often decided irrespective of the learner (or the teacher.)
3. The scope and sequence is often determined by the authors, idependent of idiosyncratic needs of the students (or teachers.)
4. The number of alternative, redundant text books which could provide certain flexibility, is limited in school practice to

1-3. Usually, only one text is being used per classroom, thus limiting the students to information within a particular text book.

5. The cognitive level aimed at by the printed format text book is inflexible. Usually, it is intuitively aimed at a non-existing "Average Student".

6. The printed format of the current curriculum is by definition "non-interactive". The interaction with the information is mediated via a teacher.

In contrast, information techonology provides by its very nature, a potential change in the following aspects of the curriculum:

1. Immediately available options for changing the packaged information. Thus, a learning package which provides the "curriculum" can be updated instantly, integrated with other packages, or reshuffled according to needs.

2. The scope and sequence of the information are flexible, and using access to data bases and advanced authoring languages, can be manipulated by teachers and learners.

3. The number of alternatives and diversified topics can be increased significantly, limited only by the administrative constraints of managing individualized learning.

4. The cognitive level of the subject matter can be matched with that of the learner.

5. Advanced software provides interactive modess of learning.

In summary, one major effect information technology can impose upon the curriculum is the change from Rigid to Flexible format. Such a change could solve many of the problems teachers encounter in the classical curriculum. It follows, therefore, that we should prepare teachers and curriculum decision makers and developers to be able to cope with the transition from the static to the adjustable format. Although much remains to be resolved regarding the social, psychological and organizational aspects of a flexible curriculum, the beginnings and the trend for change are already with us. Coping with this aspect of change should become a major element in our staff development efforts.

Changes in the Instructional Pattern

In todays educational systems, instruction constitutes the major process of education. Instruction involves mediating information in the curriculum for the learner and includes making decisions about learning goals, administering learning processes, and providing learning opportunities. Most of the instruction is carried out by teachers and embodies their major professional role. Most of today instruction is held in groups (classrooms) aimed at an "average student". This format provides probably the optimal arrangement given the fact that education has to cope with masses of students, and does not have either the theory or the technology to do it otherwise (12).

The basic process of instruction can be formulated as follows:

Instruction

Curriculum Learning

The important feature of this process is that it is mostly uni-directional since the Learning hardly affects the instruction. In other words, when we know how and what the students have learned - the instruction is over.

This is where information technology offers a possible major change by introducing a feedback component:

Instruction

Curriculum Learning

The elements of feedback for instruction are currently explored by automated diagnosis (provided by artificial intelligence techniques like BUGGY (13), advanced Computer Managed Instruction, and the development of individualized instruction systems (14). The changes in instruction would enable increased productivity of learning mainly through individualizing - adapting the instructional process to the learner variables (such as cognitive style, developmental stage and learning history). Besides the continuous R & D, the second major focus in staff development should include training in individualized instruction diagnostic techniques, and adaptive instruction. Some of it has already taken place in many of the education training programs, but the unique rate of technology was evidently missing.

Now is the time to program teachers for a new type of instruction based on technology and even though the specifics of the new professional roles are only beginning to show, the trend can already be clearly defined and dealt with.

Changes at the Organizational Level of Schooling

Most of schooling today uses the following principle: Information is assembled under an organization called a school. The school provides the information in a defined place and time, using teachers and printed curriculum. In order to have access to public knowledge students have to physically come to the school.

Students School

Information

In theory, information technology allows the reversal of this organizational pattern of scholling. Information can be assessed by the individual students instead of them coming to the information. Thus, the technology can mediate between public knowledge and the students, as shown in the following diagram:

Student Information

Information could come from mediating resources such as libraries of data bases, direct resources such as television, individual data bases via international communications, or complex networks involving special interest groups, tele-conferencing, bulletin boards, etc. The very feasibility of such a reversal in the organizational pattern of

learning might lead to far reaching changes in the entire structure of the schooling system.

The only schooling system known to be based on the reversed principle, that is the flow of information to the student is the Open University. However, this organization hardly utilized information technology (except television broadcasting) and study programs are sent via mail to the students (including tests and learning instructions). Organizationally, the Open University is tailored to accept information technology. Although a limited experience, they could serve as a model for possible organizational changes which might take place in our schooling system of the future.

Generally speaking, organizational changes resulting from the availability of information technology may assume several tendencies.

a. Home as an alterntative site for learning

Much of the educaitonal software industry aims at the consumer market with learning packages mainly in language-arts, science, and mathematics.

As the home computer emerges as another appliance, (5 million sales are foreseen for the next year), and the home market grows, improvement in educational software will occur.

Even if alternative learning at home does not exclude many of the school functions, schools must eventually accommodate to an increasing percentage of their students coming to school with previous knowledge in certain areas.

The emergence of home as an alternative site for learning does not necessarily make the school obsolete. One the contrary, one possible tendency might be the stressing of the role of the school as a socializing institution, and de-emphasizing its information distribution role. The dualty in teachers role as information and scholastic knowledge mediators on the one hand and educators on the other hand, may be resolved by seeing the home as complementary to school function.

b. Special Interest Study Groups .

Currently, learning is organized on the basis of age group and geographical proximity to the school. Information technology has the potential of organizing learning groups on the basis of learning interests independent of age or place.

This organizational pattern may replace the work of the traditional classroom framework, provided other complex pertinent problems are solved.

This possibility will provide remarkable changes in the role of subject matter teachers and the degree of their specialization.

c. Educational Networks .

The communication potential of information technology has hardly been explored in schools. Its tremendous impact on business, finance, mail, entertainment and military, however, suggests great potential for "school networks" which assure an organizational pattern different from that of a traditional

school. The criteria for going on a network could vary from individual choices to social decision making.

A variety of networks ranging form families at home, local communities, and national and international groupings can be expected.

Much of the Educational Network potential is theoretical, and much more time and experience are needed before any of this becomes in organizational reality, but cretainly this is a promising trend in organizational change that has to be considered. Organizational changes could range from small re-arrangements concercing the configuration of computers at school, and introducing new types of professionals for generating and maintenance of technology at school, to large scale changes involving complex changes in employment, relationships, economical resources, political legislation, logistics and supporting systems, social arrangements and institutions. The larger the changes, the bigger the ressistance will be.

Much of the organizational development will have to be limited to empirical experimenting rather than a full scale implementation of untested ideas. It was the tendency of the educational system to rush into innovations without too much experience and data to support the introduction of the innovation.

This time, the stakes are high. The potential of infomation technology for education is very promising. However,

experimenting with the entire system may be too expensive both in social and financial terms. Thus, organizational changes should be subject to careful planning, systematic study and confined experimenting.

Concluding Remarks

The feasibility of using information technology for learning and personal development provides a remarkable challenge for education. The possibilities for amplifying our mental capacities beyond our native limits opens up a whole new frontier for education development. However, the lack of sound theoretical models and empirical evidence with respect to the actual impact of information technology on individual and institutional learning calls for recongnition of the fact that we are enterring a transitional period with many uncertainties and many unresolved issues. It is in this complex setting that decision making by educational policy makers with regard to diffusion and implementation of information technology will have to be done. It will be done under the constraints of uncertainty; but as long as we acknowledge it, informed choice can still occur.

Studies of technological change suggest that the merging of information technology and education will involve far reaching changes in the entire system much like those changes that occurred as a result of the Industrial Revolution. Changes research also suggest

an increasing degree of difficulty with growing degrees of complexity as the learning unit changes - from individual to group to organization. It is recommended, therefore, that the organizational development of technology-based education should proceed with careful planning in order to minimize the social cost of hasty changes based on unrealistic expectations and beliefs.

Preparing the educational system for the "Industrial Revolution" will require organizational development consisting of two steps. The first step should concentrate on staff development. In a complimentary paper we will suggest concentrating on Information Literacy as the hub of training teachers at all levels of education. The following trends in change are suggested as conceptual guidelines for such staff development efforts:

a. The change from fixed to flexible curriculum format.

b. The change from indirect to direct access to knowledge.

c. The change from "whole group" to individualized instruction.

d. The change in the professional role of the teacher.

The second step in organizational development involves confined and controlled experimentation in the organizational changes needed to optimize the merging of information technology with school systems. Issues concerning the configuration of hardware, software development and logistics, communication networks, human engineering problems, changes in grouping and streaming, testing and diagnosis, equity issues and cost benefit problems, all require major policy

formulation and careful analysis. We strongly recommend not to rush and experiment with the entire educational system . Such an approach might prove as an ecological disaster with enormous social costs and educational and political damage. Social technology and careful planning should be applied before proceeding with massive diffusion and implementation of computers, communications and software. Wherever applied, technology has always proven to be a mixed blessing. Let us learn from past experience and not waste the potential opportunities offered to education by information technology. We should all be about solving educational problems, not creating new ones.

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